

**National Aeronautics and Space Administration
Washington, DC**

NASA ADVISORY COUNCIL

Human Exploration and Operations Committee

April 14-15, 2014

**NASA Headquarters
Washington, DC**

MEETING MINUTES

Ken Bowersox, Chair

Bette Siegel, Executive Secretary

**Human Exploration and Operations Committee
NASA Headquarters
Washington, DC
April 14-15, 2014**

**MEETING MINUTES
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**NASA ADVISORY COUNCIL
HUMAN EXPLORATION AND OPERATIONS COMMITTEE
NASA Headquarters
Washington, DC**

**PUBLIC MEETING
April 14-15, 2014**

Monday, April 14, 2014

Call to Order and Announcements

Dr. Bette Siegel, Executive Secretary for the NASA Advisory Council (NAC) Human Exploration and Operations (HEO) Committee, called the public session of the Committee meeting to order at 10:00 a.m.

Opening Remarks

Dr. Siegel introduced Mr. Ken Bowersox, HEO Committee Chair. He welcomed the Committee members to the first day of the Committee meeting.

Status of Human Exploration, Operations, and Budget

Mr. Bowersox introduced Mr. William Gerstenmaier, Associate Administrator (AA), Human Exploration and Operations Mission Directorate (HEOMD), NASA Headquarters (HQ). Mr. Gerstenmaier discussed NASA's Exploration Strategy. He reviewed the reasons for human space exploration. It expands human knowledge and experience, ignites imaginations, leads to science and technical advances, creates a vision of a better future for the next generations, garners national prestige, and unites nations around a common goal. He described how robots and humans both advance exploration. Robots help explore distant and hazardous environments. Human explorers provide greater speed, intuitive ease, and efficiency than robots. Mr. Gerstenmaier described three zones that make up NASA's building blocks to Mars. The Earth Reliant zone is used for missions that last from 6 to 12 months and allows the crew to return to Earth within hours. This is low Earth orbit (LEO) and involves mastering fundamentals aboard the International Space Station (ISS). The Proving Ground zone is used for missions that last 1 to 12 months and allows the crew to return to Earth within several days. These missions involve traveling beyond LEO with the Space Launch System (SLS) and the Orion Multi-Purpose Crew Vehicle (Orion or MPCV). The Earth Independent zone is used for missions that last 2 to 3 years and requires months before the crew can return to Earth. Planetary independence is established in this zone by exploring Mars, its moons, and other deep space destinations. Mr. Gerstenmaier noted at least four 130-ton class rockets will be needed to place crew on Mars' surface.

A chart showing the Capability Driven Framework was presented. These are incremental steps to steadily build, test, refine, and qualify capabilities that lead to affordable flight elements and a deep space capability. Mars is shown on the chart as the ultimate human destination in the next decades. Mr. Gerstenmaier presented a chart showing six key strategic principles for a sustainable program:

1. Executable with current budget with modest increases;
2. Application of high Technology Readiness Level (TRL) technologies for near term, while focusing research on technologies to address challenges of future missions;
3. Near-term mission opportunities with a defined cadence of compelling missions providing for an incremental buildup of capabilities for more complex missions over time;
4. Opportunities for U.S. commercial business to further enhance the experience and business base learned from the ISS logistics and crew market;
5. Multi-use, evolvable space infrastructure; and
6. Significant international and commercial participation, leveraging current ISS partnerships.

Mr. Gerstenmaier acknowledged that the one percent budget increase planned for NASA is more modest than what will be needed and that he does not expect to see the necessary modest increase in the future. He explained that the techniques needed for the Asteroid Redirect Mission (ARM) must “feed forward” to the Mars mission. For example, the robotic spacecraft for the ARM will be used for Mars cargo missions. Mr. Gerstenmaier noted that no other country is building an Orion capsule to take crew into deep space or building a deep space rocket like the SLS. Russia and China now believe that they need to develop a deep space rocket. He feels it would be advisable, therefore, to leverage international participation.

A chart showing the Global Exploration Roadmap was discussed. Mr. Gerstenmaier explained that it is not a NASA plan; it is a roadmap laid out by NASA, together with the international partners. He noted that the international partners are very interested in conducting lunar activities. NASA can assist them if they wanted to produce a lunar lander. NASA will focus on the Mars problem and allow the partners to focus on the Moon problem. He conceded that the Moon would allow more experience in low gravity than can be obtained on the ISS.

Mr. Gerstenmaier explained that the ISS is a platform that can be used to understand and develop countermeasures for human health and performance risks. Radiation shielding is going to be very difficult to develop. The Proving Ground around the Moon will enable new techniques for radiation shielding to be developed. NASA is looking at using magnetic shielding and drugs. In addition, the National Institute of Medicine is reviewing the ethical standards for radiation exposure. He explained that the next step beyond the ISS will be a crew-tended habitat in cis-lunar space. It builds off the ARM and the ISS and allows for Mars operational strategies to be developed. He described how Commercial Crew and Crew Transportation are freeing NASA to explore beyond LEO. NASA is now acquiring ISS cargo services commercially.

Slides were presented showing the SpaceX C1 launch, the SpaceX C2+ launch, the Orbital A-One launch, the Orbital ORB-D1 launch, the SpaceX Dragon capture, and the Orbital Cygnus capture. A chart was presented showing the Commercial Crew partners: Boeing, SpaceX, and Sierra Nevada Corporation (SNC). Mr. Gerstenmaier discussed a slide depicting the Commercial Crew Program (CCP) from 2010 through 2017, covering Commercial Crew Development (CCDev), Commercial Crew Development Round Two (CCDev2), Commercial Crew Integrated Capability (CCiCap), and Commercial Crew transportation Capability, phases one (CPC) and two (CCTCap). He reported that the intention is to select a contractor for Commercial Crew by August or September.

Mr. Gerstenmaier briefed the Committee on the status of Exploration Flight Test One (EFT-1), Exploration Mission One (EM-1), Orion, SLS, and Ground Systems Development and Operations (GSDO). EFT-1 will lift off on a Delta IV Heavy rocket, make two orbits around the Earth and re-enter at 80 to 85 percent of the speed that would be experienced in a lunar return mission. A primary intent is to test the heat shield. EM-1 will be outbound for 9 days, obtain a distant retrograde orbit with help from a lunar gravity assist, stay 5 days in that orbit, then return to Earth in approximately 11 days. It will rely on four RS-25 engines that remain from the Space Shuttle Program. He noted that the flight will be able to deploy CubeSats en route that will go into lunar orbit. GSDO is modernizing the Kennedy Space Center (KSC) spaceport with the capabilities to launch spacecraft built and designed by both NASA and private industry. In response to a question from Mr. Malow, Mr. Gerstenmaier explained that the EFT-1 launch date slipped from September to December due to a change in the Air Force range manifest schedule. EFT-1 will be ready to launch in September, however, if another change in the manifest schedule permits them to do so.

Mr. Gerstenmaier briefed the Committee on the ARM. It has three components: (i) asteroid identification, (ii) an asteroid redirect robotic mission using high-power Solar Electric Propulsion (SEP) to redirect an asteroid to lunar distant retrograde orbit, and (iii) an asteroid redirect crewed mission, which will be an Orion and SLS-based crewed rendezvous and sampling mission to the relocated asteroid. He explained the ARM's objectives. It will provide systems and operational experience needed for human exploration of Mars. It will demonstrate advanced SEP. It will enhance detection, tracking, and characterization of near-Earth asteroids (NEAs), enabling an overall strategy to defend Earth. It will demonstrate basic planetary defense techniques that will inform impact threat-mitigation strategies. It will benefit scientific and partnership interests by expanding knowledge about small celestial bodies and enabling the mining of asteroidal resources. He explained that the ARM builds on investments already being made by NASA. There are two options for the asteroid redirect robotic mission. Option A is to rendezvous with an NEA less than 10 meters in diameter. Option B is to rendezvous with a much larger NEA that is approximately 100 meters in diameter and to retrieve a 2 to 3 meter diameter boulder from that asteroid. In response to a question from Mr. Jim Odom, Mr. Gerstenmaier explained that reaching the asteroid in the ARM would require a 1.5 year flight time using SEP. A slide was presented showing how the ARM provides capabilities for deep space and Mars missions. Mr. Gerstenmaier noted that NASA's focus on Mars does not preclude NASA from lunar activities. The Moon, however, is not viewed as necessary for the

Mars missions. A chart on the Solar System Exploration Research and Virtual Institute (SSERVI) was discussed. SSERVI provides scientific, technical, and mission-defining analyses for relevant NASA programs, planning, and space missions. He described the Mars 2020 mission. It will be a collaboration among the Science Mission Directorate (SMD), HEOMD, and the Space Technology Mission Directorate (STMD) to offer an opportunity for investigators to propose a Mars atmospheric In-situ Resource Utilization (ISRU) demonstration. The goal of the demonstration would be to extract oxygen from Mars' atmosphere.

The Lunar Cargo Transportation and Landing by Soft Touchdown (Lunar CATALYST) program was described. Its purpose is to use NASA expertise to accelerate private-sector lunar-landing capabilities using public-private partnerships. A chart on evolutionary capabilities was shown. The chart was a matrix describing evolutionary capabilities in transportation, working in space, and staying healthy across the Earth Reliant zone, the Proving Ground zone, and the Earth Independent zone. Mr. Gerstenmaier noted that the chart is a work in progress. He showed a chart on an evolvable Mars campaign depicting where decisions need to be made in the future. Mr. Gerstenmaier explained that it is critical that SLS flies at a reasonable cadence, which would be around once a year. There is a need to look at the risks and at affordability. A modest increase above the one percent increase in the budget will be required, and partnerships will be leveraged as much as possible.

In response to a question from Dr. Pat Condon, Mr. Gerstenmaier explained that the International Partners are more Moon-focused and see the Moon as a sufficient challenge. Dr. Condon remarked that he appreciates the discipline reflected in the Exploration Strategy presentation. He asked how NASA plans to publicize the approach and generate excitement among the American public and the international community. Mr. Gerstenmaier responded that House staffers have been briefed, the NAC will be briefed, the Senate will be briefed again, it will be discussed in an upcoming workshop with the international partners, and there may be a U.S. workshop in a few weeks. He explained that the strategy is a work in progress and that the Committee can help in its development. Mr. Joseph Cuzzupoli commented that there is a difference between pioneering and deep space exploration. The money issues make it necessary to do the pioneering and research that will lead to deep space exploration. Mr. Gerstenmaier commented that there is a danger with a single point mission. Mr. Cuzzupoli remarked that the story has to come out that this is the most logical approach and that NASA could eliminate the ARM and go to the next step; however, due to the funding, the step-by-step approach is valid. Mr. Gerstenmaier responded that the Proving Ground destination around the Moon allows NASA to buy down risks. He cautioned that decisions have to be made at the right time, and if they are made too early, options in the future are removed. Mr. Malow commented that the next mission will be important because the public looks at NASA as being "historical" and is asking questions about what is next. Mr. Gerstenmaier concluded his presentation by reviewing a chart on the evaluation criteria for pathways to human space exploration. He noted that the Russians and the Chinese have decided that a 130-ton lift vehicle is needed, while NASA is already building it.

Mr. Bowersox thanked Mr. Gerstenmaier for his presentation.

Research Subcommittee Report/One Year Study and Genome Project

Mr. Bowersox introduced Dr. David Longnecker, Chair, and Dr. Brad Carpenter, Executive Secretary, NAC Research Subcommittee. Dr. Carpenter described NASA's Space Life and Physical Sciences Research and Applications Division (SLPS). SLPS executes research and application activities in space biology, physical sciences, and human research. These programs conduct fundamental and applied research to advance basic knowledge and to support human exploration in the environment of space. SLPS serves as the Agency liaison with the Center for the Advancement of Science in Space (CASIS), which is the ISS National Laboratory management organization. The SLPS organization chart was presented. A slide describing the NASA Human Research Program (HRP) was discussed. The Program's mission is to enable space exploration beyond LEO by reducing the risks to human health and performance through a focused program of basic, applied, and operational research. A chart was presented to show how HRP integrates with other NASA offices to mitigate human health risks. The HRP organization chart was presented. Dr. Carpenter discussed a chart showing human health and performance risks for the ISS, Lunar, NEA, and Mars missions.

Dr. Carpenter noted that The National Academy of Sciences (NAS) commissioned a National Research Council (NRC) Decadal Survey on NASA Life and Physical Sciences. The NRC report serves as a guide to SLPS for developing applied and fundamental research that promotes the NASA human exploration mission. A chart showing NRC Decadal Recommendations was presented. Dr. Carpenter discussed how SLPS selects research.

Dr. Longnecker noted that the Research Subcommittee was established pursuant to a March 2012 NAC recommendation to create a Subcommittee that "advises NASA on the research and educational needs that are required to support a plan for the long-range human exploration of space." The Subcommittee provides advice on research activities in HEOMD and provides assessments on the relationships between HEOMD's missions, its stakeholders, and educational sectors. He described the Subcommittee's membership and its recent activities. Dr. Longnecker presented a proposed Research Subcommittee finding to endorse open source science. Dr. Carpenter explained that open source science reflects a new approach to doing research where Principal Investigators (PIs) would propose how to use data that NASA has collected. Mr. Bowersox remarked that making databases publicly available as data is gathered would be beneficial, contrasted to how data from the Hubble Space Telescope (HST) is handled. Dr. Carpenter concurred. The Committee approved the proposed finding as follows:

The Human Exploration and Operations Advisory Committee endorses NASA's development of an Open Source approach for the Space Life and Physical Sciences GeneLab initiative, and it encourages continued development in that direction. The Committee also supports the proposed development of linkages with other public, private, and governmental organizations that can foster both operational success and public engagement with this initiative. The Research

Subcommittee of the HEO Advisory Committee will request regular updates to this initiative at each of its next several meetings.

Dr. Longnecker briefed the Committee on the One-Year Study and Genome Project. American astronaut Scott Kelly and Russian cosmonaut Mikhail Kornienko will spend one year on the ISS. Astronaut Mark Kelly, Scott's twin brother, will remain on the ground and serve as a control subject for a Twin Study Investigation. The fields to be covered in the study are genomics, transcriptomics, epigenomics, proteomics, metagenomics, and metabolomics. A chart showing selected Twin Study investigations was presented. Dr. Longnecker noted that the Russian partners are excited by new data acquisition methods that will be used in the study.

Mr. Bowersox thanked Drs. Longnecker and Carpenter for their presentation.

Status of International Space Station

Mr. Bowersox introduced Mr. Joel Montalbano, Deputy Program Manager, International Space Station Program. Mr. Montalbano briefed the Committee on the status of the ISS. He reviewed a summary "bagel" chart, which shows everything that will be flying to and from the ISS through October 2015. He described the 38 Soyuz launch. The original plan for 38 Soyuz to dock in four orbits had to be aborted because the vehicle was not in the correct attitude for the final burn. There is not much time in a four orbit rendezvous, he noted, so they diverted to a two day rendezvous. Subsequent to that launch, there has been a Progress launch with a four orbit rendezvous without incident. He noted that there had been no drop in communication during the 38 Soyuz launch, notwithstanding the Ukraine incident, which is "just noise in the system" that they work around. The 38 Soyuz crew is joining the 37 Soyuz crew already on orbit. The members on each crew were described. A slide was reviewed showing the Expedition 39 objectives. The crew averages 39.4 hours per week for payload investigations. Exercise time is not included, even though the exercise data is used for science. A chart showing an increase in crew work hours was discussed. Dr. Condon noted that "Robonaut" had been delivered to the ISS three years ago and asked whether it has been able to free humans on board from many mundane tasks. Mr. Montalbano responded that Robonaut is scheduled to receive in the next two years an upgraded leg accessory pack and a battery pack, which it needs to progress. He noted that there has been limited testing on it and he agreed to provide Dr. Condon with more detailed information.

Mr. Montalbano discussed a chart on ISS research statistics. There have been, to date, 1502 investigations on the ISS. The investigations have led to over 700 scientific result publications. Charts on the status of ISS consumables were reviewed. The charts show the dates that reserve levels and zero supplies will be reached, depending upon resupply missions. Mr. James Voss asked whether on-going research would be discontinued if the next SpaceX mission was not successful. Mr. Montalbano responded that some human research investigation would continue; however, HRP and the biological sciences would be significantly impacted. In response to a question from Mr. Richard Malow, Mr. Montalbano noted that Soyuz, Progress, Orbital, and SpaceX all fly supply missions. Several charts on ISS vehicle issues were reviewed by

Mr. Montalbano. The Carbon Dioxide Removal Assembly (CDRA) was discussed. CDRA is a part of the ISS Environmental Control and Life Support System (ECLSS). The CDRA provides carbon dioxide removal from the ISS. Mr. Montalbano explained that there are two CDRA's on board at this time and each lasts for several months. They are large systems and the technology needs to be improved before making a one-year trip to Mars. Mr. Bowersox remarked that the primary problems with CDRA are microgravity issues that cannot be tested on Earth.

Mr. Montalbano briefed the Committee on the Extra-Vehicular Activity (EVA) suit investigation. Engineers still have not determined what caused the suit's helmet to fill with water. Silica accumulation from ion exchange beds is the prime suspect. A new suit is to be flown to the ISS and the old one returned on SpaceX-3. In the interim, a water-absorption pad and a snorkel have been installed in the suit in case there is a recurrence. Mr. Montalbano described NASA's plans to conduct an EVA to remove and replace (R&R) a failed multiplexer/de-multiplexer (MDM). The failed MDM is a computer external to the ISS. It is a back-up to another MDM inside the ISS. There is a spare MDM that has been on board for over 13 years that will be used to replace the failed MDM.

Status charts were reviewed for the Orbital-1 Mission, the SpaceX-3 Mission, the Orbital-2 Mission, the SpaceX-4 Mission, and the Automated Transfer Vehicle (ATV)-5 Mission. Orbital-1's Cygnus transferred 1462 kilograms (kg) of cargo to the ISS and trash loading was complete at 1477 kg. The Antares performance was nominal. All mission objectives and mission success criteria were met. SpaceX-3 is to berth with the ISS on April 16, 2014. Final cargo loading for Orbital-2 is scheduled for May 3, 2014. The First Stage Acceptance Test Procedure (ATP) for SpaceX-4 is scheduled to begin in early June 2014. The ATV-5 vehicle processing in Kourou is going well. Its cargo manifest is over 6000 kg. Mr. Montalbano discussed the ISS Top Program Risk Matrix. The three highest risks are lack of assured access to ISS, pension harmonization for a major contractor's retired employees, and ISS operations budget reductions. The U.S. Orbital Segment (USOS) primary structure life extension was discussed. Mr. Montalbano reported that everything is cleared through 2028. The P6 IEA truss does, however, need more analysis. Mr. Montalbano noted that it was the first truss installed on the ISS and that the trusses were designed to launch twice.

A chart was presented on projected event peak life drivers by hardware. In response to a question from Mr. Cuzzupoli, Mr. Montalbano explained that solar panels are not on the chart because the solar panels are not running near capacity and are fully charged by noon. In response to a question from Mr. Robert Sieck about nuisance alarms, Mr. Montalbano stated that there have been around ten false alarms per year. Each alarm is treated as a real emergency. Mr. Montalbano described two new investigations on Increment 39. One is a Vegetable Production System (VEGGIE), which is the largest greenhouse ever to be flown in space. The other is T-Cell Activation in Aging, which is expected to help understand what causes a depression in the human immune system while in microgravity.

Mr. Bowersox thanked Mr. Montalbano for his presentation.

Managing Spaceflight Programs and Projects – 7120.5E Overview

Mr. Bowersox introduced Ms. Sandra Smalley, Director, Engineering and Program Management Division, Office of the Chief Engineer. Mr. Smalley briefed the Committee on NASA Procedural Requirements (NPR) 7120.5E “NASA Space Flight Program and Project Management Requirements” (hereafter referred to as 7120 or “the NPR”). The NPR became effective on August 14, 2012. It applies to all spaceflight projects; however, it does not apply to Space Act Agreements (SSAs).

Ms. Smalley described three overarching management principles for programs and projects: (i) management is based on a life-cycle with key decision points supported by life-cycle reviews (LCRs); (ii) a designated Decision Authority (DA) makes transition decisions at key decision points during the life-cycle with assistance from reviews by a Governing Program Management Council (GPMC); and (iii) checks and balances come from separating programmatic and institutional authority, from independent reviews, and from allowing dissenting opinions. All space flight projects, regardless of cost, must comply with the NPR unless the DA grants an exception pursuant to a formal process called “tailoring.” It is expected that programs and projects will need tailoring to achieve mission success in an efficient and economical manner. Examples of HEO tailoring were given. A chart describing the separation of authorities was discussed. Programmatic Authority resides within the Mission Directorates and their respective programs and projects. Institutional Authority resides with HQ and associated NASA Center organizations. Within the Institutional Authority are three Technical Authorities: Engineering, Safety and Mission Assurance, and Health and Medical. The Technical Authorities provide an independent view of program or project activities and approve changes and waivers to the Technical Authority’s requirements. The Program or Project Manager remains responsible for the outcome of the program or project.

A chart on space flight project categorization was presented. There are three categories. Category 1 is for projects with life-cycle costs over \$1 billion, human spaceflight, and flights involving significant radioactive material. Category 3 is for low- and medium-priority-level flights with life and cycle costs and below \$250 million (M). All other flights are Category 2. The DA for Category 1 projects is a NASA Associate Administrator. The DA for Category 2 and 3 projects is a Mission Directorate Associate Administrator. Charts showing a simplified program life-cycle and a simplified space flight project life-cycle were presented. Ms. Smalley described the independent life-cycle review process. It is convened by the DA and conducted by a Standing Review Board (SRB). The SRB’s recommendation is presented to the DA and readiness decisions for the next phase are made by the DA. Ms. Smalley explained that independent life-cycle reviews provide programs and projects with objective assessments, help senior management understand how the program or project is performing, and provide a credible basis for making decisions to proceed into subsequent phases. SRBs remain with a project through its life-cycle. This provides a strong advantage in terms of continuity and familiarity

with purpose, history, programmatic and technical approach, challenges, risks, and issues. SRB members must be competent, current, and independent. SRB members and consultants to the SRB can be selected from within the Agency and from external sources. The membership is approved by the convening authority.

In response to a question from Dr. Condon, Ms. Smalley stated that the need for tailoring project management should be identified early during formulation. Dr. Condon observed that while good process discipline is needed, it limits the flexibility of the program manager. Mr. Bowersox remarked that it would be helpful to have a dollar threshold established for the NPR because the tailoring the process is time intensive. Mr. Cuzzapoli questioned whether the person with programmatic authority also should be responsible for the budget. Dr. Condon advised that people with authority to say “no” should be encouraged to be part of the process from a constructive standpoint. In response to a question from Mr. Cuzzapoli, Ms. Smalley explained that dissenting opinions may be escalated up the chain of command. Dr. Condon remarked that care should be exercised so that the process does not become the product. The process is supposed to assist the manager in delivering cost, schedule, and performance. Too often, he noted, it is reversed, and the manager serves the process. Mr. Sieck asked Ms. Smalley whether 360 reviews were performed on the NPR and how she knew whether the process itself is performing well. She responded that formal 360 reviews are not performed, but that surveys are conducted. She noted that external reporting requirements to Congress and the Office of Management and Budget (OMB) have escalated enormously over time. In response to a question from Mr. Bowersox about whether project reserves need to be protected, she explained that Mission Directorates cannot “rob from projects” after formulation.

Mr. Bowersox thanked Ms. Smalley for her presentation.

Status of Commercial Space Development

Mr. Bowersox introduced Ms. Kathy Lueders, Acting Program Manager, Commercial Crew Program. Ms. Lueders presented the CCP Mission Statement: *“NASA’s Commercial Crew Program (CCP) is facilitating the development of safe, reliable and cost-effective human space transportation capabilities to and from low-Earth orbit by private industry in the United States. CCP is enabling the eventual purchase of a NASA certified crew transportation system for International Space Station services. CCP is leading NASA’s hybrid approach of investment and contracting.”*

The CCP evolution was described by Ms. Lueders. She described the CCDev2 initiative with Blue Origin. This initiative began with a SSA with funded milestones. It is currently unfunded. The Blue Origin crew transportation system comprises a reusable biconic Space Vehicle (SV) to be launched first on an Atlas V launch vehicle. Blue Origin is simultaneously developing its own Reusable Booster System (RBS). The milestones have been around maturing that design and NASA has been providing engineers from Marshall Space Flight Center (MSFC) to help on the

propulsion system design. The capsule is designed to ride on multiple launch vehicles, including the Blue Origin RBS. Total NASA investment has been \$22 M.

Ms. Lueders described the CCiCap initiative. SSAs for this initiative have been entered into with Boeing, SNC, and SpaceX. Boeing's crewed space transportation system is comprised of the reusable CST-100 spacecraft, the Atlas V launch vehicle, mission operations, and ground systems. The total expected NASA investment for the Boeing contract is \$460 M. SNC is partnering heavily with Lockheed. Its crew transportation system consists of the Dream Chaser lifting body spacecraft, the Atlas V launch vehicle, mission operations, and associated ground systems. The SNC Dream Chaser is a reusable, piloted lifting-body spacecraft, derived from the NASA HL-20 spacecraft design. The total expected NASA investment for the SNC contract is \$227.5 M. SpaceX has been leveraging off its commercial cargo experience. SpaceX's crew transportation system is based on the Dragon spacecraft and Falcon 9 launch vehicle originally developed for ISS cargo missions. Initially designed to carry cargo, the Dragon's components are being modified for added safety and crew accommodations. The total expected NASA investment for the SpaceX contract is \$480 M.

A slide describing the Certification Strategy was presented by Ms. Lueders. She discussed Certification Products Contracts (CPCs). The CPC objective is the delivery, technical interchange, and NASA disposition of early life-cycle certification products that are specifically related to an integrated Crew Transportation System (CTS) for ISS Design Reference Missions (DRM). The purpose is to insure that the contractors' designs will meet NASA's requirements. In December 2012, Boeing, SNC, and SpaceX were each awarded CPCs for \$10 M or less, covering the submittal and discussion of specific, early life-cycle certification products. The contract requires initial and final deliverables for Alternate Standards, Hazard Reports, Verification and Validation (V&V) Plan and variance requests to NASA requirements, and a Certification Plan.

In August 2014, NASA will award Commercial Crew Transportation Capability (CCtCap) contracts. These contracts will require the contractor to develop and certify a commercial Crew Transportation System (CTS) that can provide NASA crew safe transportation to the ISS as soon as possible, with a goal of no later than 2017. The CTS development will enable the purchase by NASA of commercial services to meet NASA's station crew transportation needs, once NASA certifies the capability. This will be a phased acquisition using competitive down-selection procedures in a full and open competition. The award will be a firm-fixed-price, performance-based contract with a fixed-price Indefinite Delivery/Indefinite Quantity (ID/IQ) element. Mr. Sieck asked whether the competitors are being pressured or guided by NASA towards reusable first stages. Ms. Lueders responded that there is no requirement for reusable first stages and that NASA's goal is to obtain a cost-effective capability. NASA focuses the commercial crew requirements on what will help NASA crew fly safely. The competitors have to balance that against cost-effectiveness. Mr. Bowersox asked Ms. Lueders to describe the biggest threat to achieving a launch with crew in 2017. She replied that the biggest threat is NASA being able to understand and accept the necessary design pace.

Mr. Bowersox thanked Ms. Lueders for her presentation.

Adjournment

Mr. Bowersox adjourned the public session of the committee meeting for the day at 5:00 p.m. Dr. Siegel notified the members that the following day's public meeting would convene at 10:30 a.m.

Tuesday, April 15, 2014

Call to Order and Announcements

Dr. Bette Siegel called the public session of the HEO Committee meeting to order at 10:30 a.m. She announced that it is a public meeting. Minutes will be taken and posted on-line. There will be an opportunity for the public to make comments at the end of the meeting.

Opening Remarks

Dr. Siegel introduced Mr. Bowersox, HEO Committee Chair.

Status of Exploration Systems Development

Mr. Bowersox introduced Mr. Daniel Dumbacher, Deputy Associate Administrator for Exploration Systems and Development (ESD) Division, HEOMD. Mr. Dumbacher briefed the Committee on recent progress that has been made in ESD. He presented a video called "Acing the Test," showing the hardware that is being developed across ESD's three programs. He reviewed the ESD Summary Schedule chart for programs through FY18. The Orion is being prepared for EFT-1. The date for the test flight has been moved from September to December due to manifest schedule changes by the Air Force. The test flight will be ready for launch in September if the manifest schedule allows. The European Service Module for Orion has a preliminary design review scheduled for next May. The systems being developed by GSDO for KSC have passed preliminary design review and are moving into the detailed design effort. Slides showing the Orion crew and service modules were presented. Mr. Dumbacher noted that the heat shield will be using the same tile technology that was used for the Space Shuttle. The crew module will be stacked with the service module in the Operations and Checkout Building in Florida. A slide was presented showing the Orion Launch Abort System. This is a large rocket that will be inert for EFT-1; the only active part to be used during the test will be the separation motors.

Mr. Dumbacher discussed a slide showing the SLS core stage major welding tools at the Michoud Assembly Facility (MAF). He noted that NASA is building the world's largest rocket in a state-of-the-art facility. The slide showed the tools that are being used to make the tank domes and cylindrical sections. The sections will be stacked for the liquid oxygen and liquid hydrogen tanks. In response to a question from Mr. Odom, Mr. Dumbacher reported that there have

been no issues with the welds. A slide was presented showing the SLS core stage Vertical Assembly Center (VAC) progress. The tower installation in the VAC will be completed in June 2014. Mr. Dumbacher showed a slide depicting the SLS core stage and main engines B-2 Test Stand. It is on schedule, under budget, and will be ready in 2016. SLS avionics progress was described. The vehicle controls itself and reports to Orion if there is a need to abort. The SLS RS-25 Main Engine test-firing is scheduled for the summer 2014 at Stennis Space Center (SSC). Sixteen of these engines from the Space Shuttle Program are at SSC in storage. Some modifications to the engines are needed to work with the new interface on the SLS core stage. A slide was presented showing a SLS Booster development motor firing. To save funds, the fourth development motor will be used as the first test motor. The first qualification firing is expected later this year. Mr. Dumbacher noted that these are five segment motors, compared to the four segment motors used for the Space Shuttle.

Mr. Dumbacher discussed a chart on the GSDO Concept of Operations. Only High-Bay 3 at the Vertical Assembly Building (VAB) will be used. The work platforms there are being designed for use by multiple vehicles. Mr. Dumbacher noted that EFT-1 will be a two-orbit flight, with a reentry at 80 to 85 percent of the speed of a lunar mission re-entry. The landing will be in the Pacific with recovery assistance from the U.S. Navy. The solid rocket processing will be similar to that used on the Space Shuttle. The engines will be installed at MAF, tested at SSC, then put on a barge and shipped to KSC. He noted this was the prudent procedure to follow given the workforce. The roll-out to Pad 39B will not take 30 days as was the case for the Space Shuttle; instead, it will take only 3 to 5 days. In response to a question from Mr. Condon, Mr. Dumbacher explained that parachute testing for Orion is being conducted at the Yuma Proving Grounds. Three chutes will be deployed on the mission; if one fails, recovery will still be possible. He noted that parachute data has been shared with the Commercial Crew teams to avoid duplication of effort. In response to a question from Mr. Odom, Mr. Dumbacher explained that the plan is to perform a core stage hot-fire test. Additional testing and test firing the second and third stages will be considered only if issues arise from the core stage test. The plan, he noted, is to deal with the reality discovered along the way and to hot fire all four stages only for EM-1. The Crawler Transporter is being upgraded so that it can serve a 130-ton vehicle. New roller bearings have been installed in the crawler. EFT-1 will be launched on the Air Force side of Cape Canaveral on a Delta IV Heavy rocket. The adapter between Orion and the Delta is the same adapter that will be used on EFT-1 between Orion and SLS. Mr. Dumbacher noted that the Orion and SLS will be key elements in the ARM. He concluded his presentation by reviewing a chart illustrating that the SLS is a nation-wide effort with partners and suppliers located in 48 states.

Mr. Bowersox thanked Mr. Dumbacher for his presentation.

Public Comments

Mr. Bowersox invited comments from the public. There were none.

Committee Discussion and Deliberation

Mr. Sieck noted that he saw nothing lacking in the content from the presentations and he complimented NASA's efforts in preparing for the Committee's meeting. He remarked that Commercial Crew is doing well, and that SLS integration is a challenge, particularly because it includes foreign and commercial participants. Mr. Condon commented that the Exploration strategy described by Mr. Gerstenmaier was good. He requested that a future Committee topic be the communication strategy that complements the Exploration strategy. Ms. Nancy Ann Budden concurred that Mr. Gerstenmaier was showing a good path forward. She observed that this was the first time since President Bush that a NASA Administrator has been heard to say that NASA is going to Mars. She advised documenting that statement and further advised that there is no need to "beat up the fact" that ARM has been passed over. Mr. Bowersox noted that ARM remains part of the Exploration strategy. Ms. Budden remarked that the public is not aware of the progress being made on the actual hardware that is being developed. She suggested a finding that there is a need for an aggressive way to get that message delivered. She suggested that the Committee hold a future meeting at MAF near SSC. She also recommended that the cost and time required to comply with the NPR 7120 process be quantified. She expressed concern over a process where people who are not actual stakeholders can say "no."

Mr. Cuzzupoli expressed concern that he did not hear about a backup plan in case the Russian situation worsens. Mr. Voss concurred that there should be a plan and that the available options should be examined. Mr. Bowersox noted that he also is concerned whenever he sees the absence of a backup plan, especially for large programs. He suggested that the concern be given directly to Mr. Gerstenmaier. Mr. Cuzzupoli suggested that the Committee be briefed by program managers on how they are affected by NPR 7120. Mr. Bowersox commented that there is a need to understand the high-level program governance model. Mr. Cuzzupoli remarked that he has become an SAA supporter now that he has seen how effectively the contractors are working with the government. Mr. Longnecker remarked that the slides, charts, and meeting presentations had been the best that he has seen. He noted that at a recent meeting on the ARM, Mr. Bolden used the phrase "boots on the ground on Mars." He remarked that NPR 7120 seems to require too much oversight and that he would like to better understand everyone's role in the process. Mr. Odom noted that he was impressed with the progress being made by Commercial Crew and that he believes the Space Act is working. He especially appreciated hearing from the Research Subcommittee about research on the physical aspects of long-term spaceflight. Mr. Voss concurred with the comments about NPR 7120. He suggested that the Committee look at providing relief from it in all programs. Mr. Malow remarked that the presentations were well done. He expressed concern that the public does not know about the upcoming missions. He explained that the December mission is an opportunity to bring the program to the public's attention.

Mr. Bowersox summarized the Committee members' comments and explained that recommendations from the Committee to the NAC for the Administrator had to be actionable. He suggested that the finding from the Research Subcommittee be forwarded to the NAC. The Committee concurred, after making revisions to the language. Mr. Bowersox reviewed the

Committee's previous findings and recommendations that were submitted as well as those that had been held for future discussion.. Mr. Malow commented that the Exploration schedule could not be met within the current budget. Mr. Odom suggested complimenting NASA for the program content, despite the budget problems. Mr. Bowersox remarked that everyone is concerned with the SLS launch rate and the program's sustainability. Ms. Siegel suggested commending ESD's efforts to maintain content and schedule. Ms. Budden concurred. Mr. Bowersox noted that this was a potential finding. Mr. Condon suggested a finding to compliment the Exploration strategy discussion about three domains, and a companion finding that there is a need to see a communications strategy for the Exploration strategy. Mr. Malow suggested a recommendation that NASA produce something similar to the JPL video on the difficulty in landing a Mars rover.

Mr. Bowersox suggested a finding that endorses Mr. Gerstenmaier's Exploration strategy and expresses a need to communicate the strategy effectively. Mr. Odom suggested that the Committee be briefed on NASA's communication plan. Mr. Malow suggested using the manned mission to generate excitement. Ms. Siegel advised that the manned missions will not take place until the mid to late 2030s, which may be too far into the future to generate excitement at this time. The Committee discussed and approved a finding to endorse NASA's approach to Human Exploration. Final language for the finding will be developed after the meeting.

The Committee discussed its future agendas and work plan. Mr. Odom commented that program managers may be reluctant to criticize NPR 7120 publicly. Mr. Bowersox concurred, and suggested that the Committee meet with program managers for fact finding in a closed session. Dr. Siegel suggested holding a joint meeting on the ARM with the NAC's Science Committee and the NAC's Technology and Innovation Committee. Mr. Bowersox requested a briefing on NASA's communications strategy for the Exploration strategy.

Ms. Budden expressed the Committee's appreciation for Mr. Bowersox's style and leadership. Mr. Bowersox thanked the staff for their assistance and the Committee members for their participation.

Adjournment

Mr. Bowersox adjourned the Committee meeting at 2:00 p.m.

**NASA ADVISORY COUNCIL
HUMAN EXPLORATION AND OPERATIONS COMMITTEE**

MEETING

**NASA Headquarters
MIC 7A
300 E Street SW
Washington, DC 20546**

April 14-15, 2014

AGENDA

April 14

COMMITTEE PUBLIC MEETING

10:00 – 10:05 am	Opening Remarks	Mr. Ken Bowersox & Dr. Bette Siegel Chair & Executive Secretary
10:05 – 11:00 am	Status of Human Exploration & Operations & Budget	Mr. William Gerstenmaier Associate Administrator Human Exploration and Operations Mission Directorate (HEOMD)
11:00 – 11:15 am	<i>BREAK</i>	
11:15 – 12:15 pm	Research Subcommittee Report/ One Year Study and Genome Project	Dr. David Longnecker & Dr. Brad Carpenter Chair & Executive Secretary NAC Research Subcommittee
12:15 – 1:15 pm	<i>LUNCH</i>	
1:15 – 2:15 pm	Status of International Space Station	Mr. Michael Suffredini Program Manager International Space Station
2:15 – 3:15 pm	NASA Program Requirements (NPR) 7120	Ms. Sandra Smalley Director, Engineering & Program Management Division Office of the Chief Engineer
3:15 – 3:30 pm	<i>BREAK</i>	
3:30 – 4:45 pm	Status of Commercial Space Development	Ms. Kathy Lueders Acting Program Manager Commercial Crew Program
4:45 pm	<i>ADJOURN</i>	

April 15

COMMITTEE PUBLIC MEETING

10:30 – 10:33 am	Opening Remarks	Mr. Ken Bowersox & Dr. Bette Siegel Chair & Executive Secretary
10:33 – 11:30 am	Status of Exploration Systems Development	Mr. Daniel Dumbacher Deputy Associate Administrator for Exploration Systems & Development Division, HEOMD
11:30 – 11:35 am	Public Comments	
11:35 – 12:00 pm	Committee Deliberations and Discussion	
12:00 – 12:30 pm	<i>LUNCH</i>	
12:30 – 2:00 pm	Committee Deliberations and Discussion	
2:00 pm	<i>ADJOURN</i>	

**Human Exploration and Operations Committee Membership
April 2014**

Mr. Ken Bowersox <i>Chair</i>	Former NASA astronaut and retired U.S. Navy Captain
Dr. Bette Siegel <i>Executive Secretary</i>	NASA Headquarters
Ms. Shannon Bartell	Former Director of Safety & Mission Assurance, KSC
Ms. Nancy Ann Budden	Director for Special Operations Technology, Office of the Secretary of Defense
Dr. Leroy Chiao	Former NASA Astronaut and ISS Commander
Dr. Stephen "Pat" Condon	Aerospace Consultant, former Commander of the Ogden Air Logistics Center, the Arnold Engineering Development Center, and the Air Force Armament Laboratory
Mr. Joseph Cuzzupoli	Former Assistant Apollo Program Manager, Rockwell, and manager of the Space Shuttle Orbiter Project
Mr. Tommy Holloway	Former Space Shuttle and ISS Program Manager
Mr. Lon Levin	President, SkySevenVentures
Dr. David E. Longnecker	Director, Health Care Affairs, Association of American Medical Colleges (AAMC), member of the National Academy of Sciences Institute of Medicine (IOM)
Mr. Michael Lopez-Alegria	Former NASA astronaut and retired U.S. Navy Captain, President of the Commercial Spaceflight Federation
Mr. Richard Malow	Distinguished Advisor at the Association of University for Research in Astronomy (AURA)
Mr. James Odom	Former NASA Associate Administrator for Space Station Freedom
Mr. Bob Sieck	Former Space Shuttle Launch Director
Mr. James Voss	Former NASA astronaut and retired U.S. Army Colonel, Scholar in Residence, Department of Aerospace Engineering Sciences, University of Colorado, Boulder

**Human Exploration and Operations Committee
NASA Headquarters
Washington, DC**

April 14-15, 2014

MEETING ATTENDEES

Committee Members:

Bowersox, Ken, <i>Chair</i>	U.S. Navy (<i>Ret.</i>)
Siegel, Bette, <i>Executive Secretary</i>	NASA Headquarters
Budden, Nancy Ann	Office of the Secretary of Defense
Condon, Stephen "Pat"	Aerospace Consultant
Cuzzupoli, Joseph	Aerospace Consultant
Longnecker, David	Association of American Medical Colleges
Malow, Richard (telecom)	AURA
Odom, James (Jim)	Aerospace Consultant
Sieck, Bob	Aerospace Consultant
Voss, James	University of Colorado, Boulder

NASA Attendees:

Broadwell, Marguerite	NASA HQ
Bryant, Devin	NASA HQ
Buck, Josh	NASA HQ
Carpenter, Brad	NASA HQ
Castello, Kirt	NASA HQ
Dumbacher, Dan	NASA HQ
Gates, Michelle	NASA HQ
Gerstenmaier, William	NASA HQ
Guthromson, Jayleen	NASA HQ
Irving, Rick	NASA HQ
Johnson, James	NASA HQ
Maxwell, Theresa	NASA HQ
Montalbano, Joel	NASA/JSC
Rigney, John	NASA HQ
Smalley, Sandra	NASA HQ
Smith, Gwyn	NASA HQ
Wright, Elsie	NASA HQ
Lueders, Kathy	NASA HQ

Other Attendees:

Frankel, David	PB Frankel, LLC
Gilbert, Chris	[not affiliated]
Hale, Wayne	NASA Advisory Council
Leone, Dan	Space News
Swear, Natalie	Dept. of Defense/Army

**Human Exploration and Operations Committee
NASA Headquarters
Washington, DC**

April 14-15, 2014

LIST OF PRESENTATION MATERIAL

- 1) NASA's Exploration Strategy [Gerstenmaier]
- 2) Research Subcommittee Report [Carpenter]
- 3) International Space Station Program Status [Suffredini]
- 4) Managing Spaceflight Programs and Projects – 7120.5E Overview [Smalley]
- 5) Commercial Crew Program [Lueders]
- 6) Status of Exploration Systems Development [Dumbacher]